Space Weather Technical Forecast

Issued on Sunday, 17 March 2024 at 13:19 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Recent S1 proton levels declining. Oncoming sunspot regions bringing a chance of M-flares. Slight chance of glancing CME influences. Potential for an Earth-directed CME to arrive late in the period - pending analysis.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity measured at GOES16 and 18 increased to moderate following an M3.5 flare at 16/1635 UTC from a region currently yet to round the southeast limb, with a further M1.2 flare recorded from the same region at 16/2155UTC, this in contrast to previous background X-ray activity near the B/C boundary. There are currently four numbered sunspot regions on the visible disc, and two unnumbered, with all of these magnetically simple. The main growth trend was seen in AR3613, which continued to see spreading, proliferation of spots and areal growth in its penumbral leader during the period. Further growth and spread was also seen in the unnumbered region near centre-disc north. There is now a large sunspot emerging around the northeast limb, which is currently unnumbered, although this is difficult to analyse at this stage due to foreshortening effect.

The main event to note during the past 24 hours was a large filament lift-off near the south-centre disc around 17/0230UTC, which occurred just south of AR3613 and produced a CME, which is currently under-going analysis. There appears to be two segments to this filament eruption, one section heading SE and a second heading SW. Dimming was evident and seen in SDO/AIA 211 imagery. Given its location, these could be potentially Earth-directed, with a possible (estimated) arrival sometime either late on 19th or early 20th March - pending results.

Solar Wind / Geomagnetic Activity: Solar wind speeds, as observed at L1 by ACE were perhaps reflective of a slow exit from the faster wind regime of CH09/+, with the phi angle accordingly positive (away from the Sun) throughout. The solar wind speed showed a slowly declining trend from around 400 to 350km/s, with the density steady in single-figures ppcc. The IMF was weak throughout at 3-5nT, with the north-south component generally weakly positive, -2 to 4nT. The net result of the above solar wind measures was for provisionally Quiet geomagnetic activity throughout.

Energetic Particles / Solar Radiation: GOES18 high energy (greater than 10MeV) proton flux showed an initial enhancement above S1 levels in the wake of the 15/0610UTC C5.9 flare from Ex-AR3599. This level was first breached from 15/2050UTC and reached a maximum of 17pfu at 16/0635UTC. Values subsequently declining, falling below S1 levels by 16/1600UTC and continuing to decline towards current slightly elevated levels.
High energy electron flux (greater than 2MeV) observed at GOES16 was at Normal Background levels. The observed 24-hour fluence was steady below the Active threshold, with the value at 17/0001UTC 5.17e6 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Low to moderate solar activity expected with ongoing C-class activity and a

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rising chance of further isolated M-class activity, this looking to be largely as a result of the approaching regions due over the eastern limb later in the current UTC weekend.

Solar Wind / Geomagnetic Activity: There are potentially up to three glancing incidence CME shocks expected to pass 1AU through days 1-3 (17-19 Mar). In the absence of significant CME activity solar winds are expected to remain at generally background to slightly elevated levels with any fast wind enhancements expected to be relatively minor in the period. Mostly Quiet or Unsettled (Kp 0-3) conditions are expected, with a chance of Active (Kp 4) intervals and a slight chance of an isolated G1/Minor Storm (Kp 5) interval on days 1-3 (17-19 Mar) given the potential for glancing CME influence. Potential for a more Earth-directed CME from the aforementioned filament lift-off observed at 17/0230 UTC - pending results.

Energetic Particles / Solar Radiation: Proton flux at GOES18 has fallen below S1 levels as the the response to the 15/0610UTC C5.9 flare continues to decline. A regression to a background risk for further S1 storms is expected into the new UTC working week given the apparently magnetically simple sunspot regions facing Earth at present.

High energy electron flux (greater than 2MeV) is currently at Background levels and expected to generally remain so in the likely absence of significant sources of enhancement. 24-hour integrated fluence is Expected to remain below the Active threshold throughout.

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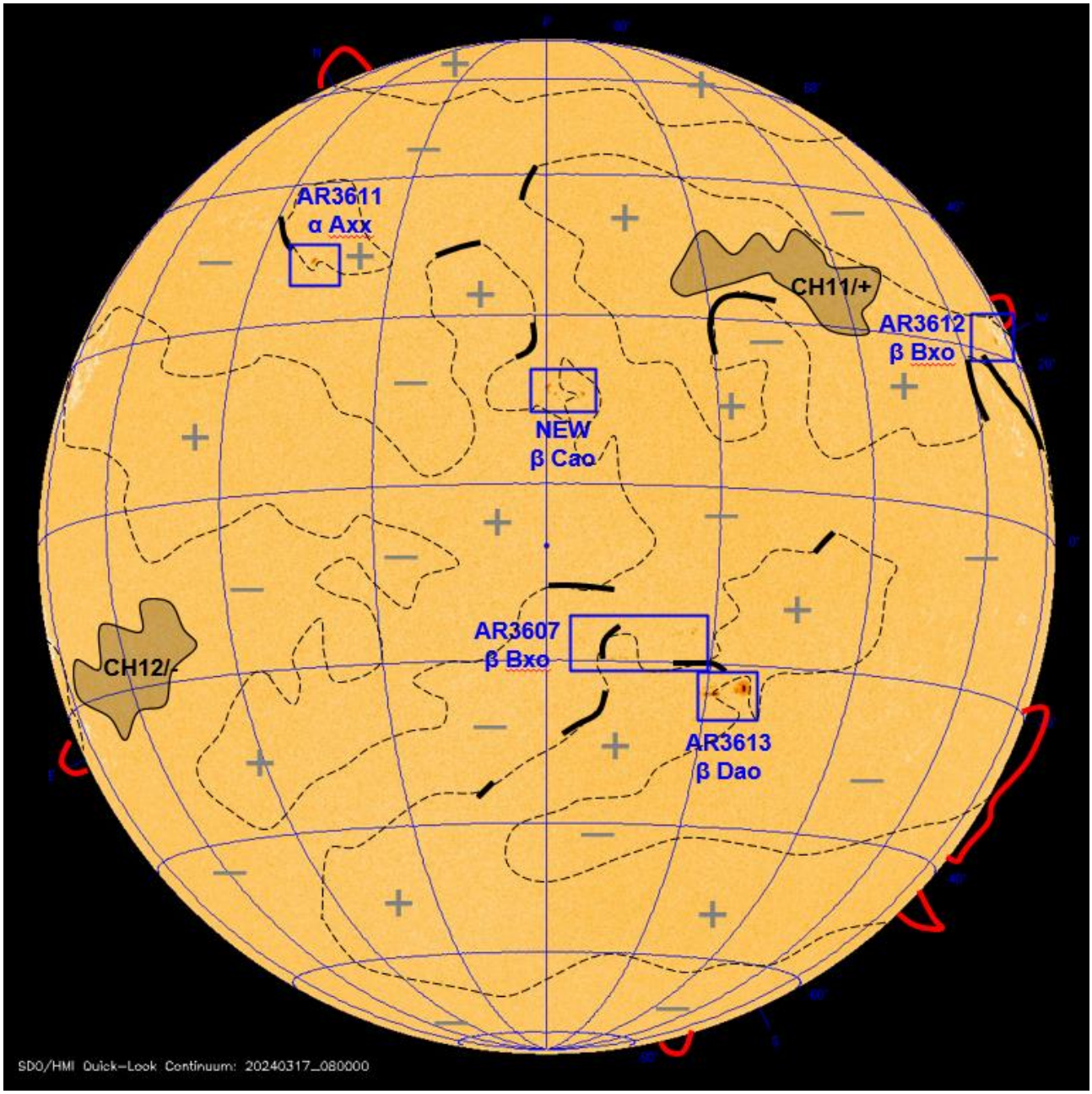
Figure 1. Solar Analysis Valid 17/0800 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

The current cohort of CMEs with possible Earth-bound components include three main events, although all of these are glances at worst and would most likely have to arrive in combination with each other for any notable effects. These are: Firstly, the CME associated with the long-period C5.9 flare from Ex-AR3599 15/0610UTC over the west limb. Secondly, a filament eruption from north-centre disc on 14 March; and thirdly, a CME from 15 March with an unknown source.

The main event to note during the past 24 hours was a large filament lift-off near the south-centre disc around 17/0230UTC, which occurred just south of AR3613 and produced a CME, which is currently under-going analysis. There appears to be two segments to this filament eruption, one section heading SE and a second heading SW. Dimming was evident and seen in SDO/AIA 211 imagery. Given its location, these could be potentially Earth-directed, with a possible (estimated) arrival sometime either late on 19th or early 20th March - pending results.

In the absence of significant CME activity solar winds are expected to remain at generally background to slightly elevated levels with any fast wind enhancements expected to be relatively minor in the period, with the previously identified CH10/- in the western hemisphere no longer visible and limited enhancement forecast from the higher latitude CH11/+ in the northwest. The time of year acting to reduce the risk of significant interaction with this positive coronal hole as we approach the equinox.

Mostly Quiet or Unsettled (Kp 0-3) conditions are expected over the period, with a chance of Active (Kp 4) intervals and a slight chance of isolated G1/Minor Storm (Kp 5) intervals on days 1-3 (17-19 Mar) given the slight potential for glancing CME influence. The aforementioned CME associated with a recent filament eruption near south-centre disc has the potential to be Earth-directed, given its location, which could give an enhancement, possibly up to G1/minor storm levels later in the period - pending results.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	10	10	10	10
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Potential for an Earth-directed CME following a filament eruption near south-centre disc early on the 17 Mar, which is currently under-going further analysis.

Figure 2: GONG H-Alpha (greyscale) imagery from El Teide, Spain – shows filament (left) before the eruption and afterwards (right).

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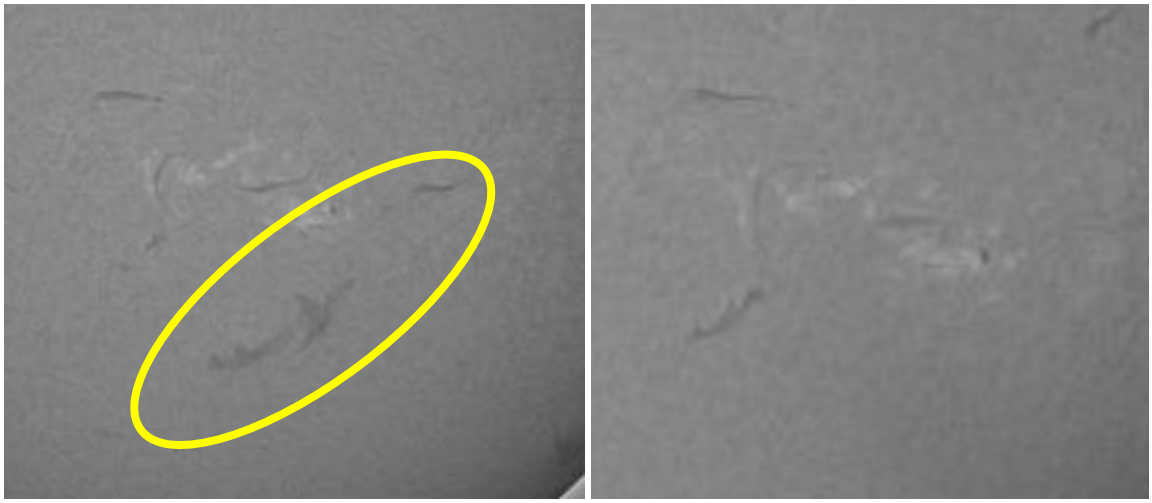
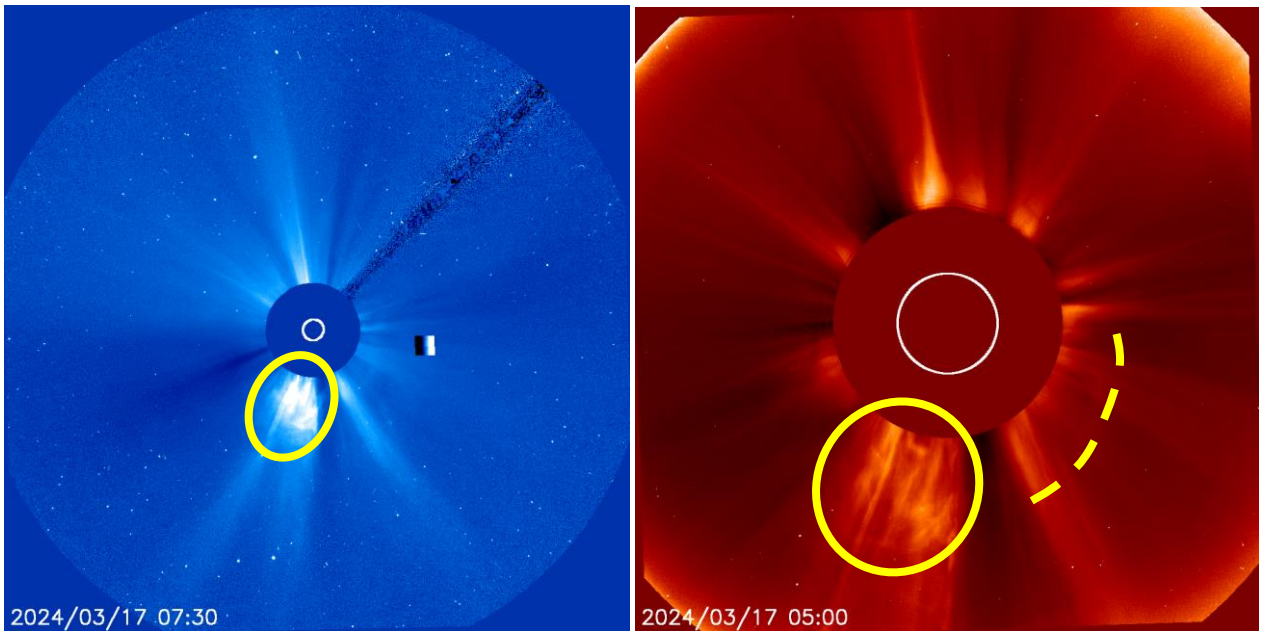


Figure 3: LASCO-C3 (left) and LASCO-C2 (right) shows the CME associated with the (see above) filament eruption, just south of AR3613, which appears to be in two segments – highlighted in LASCO-C2. Currently under-going further analysis for any potential Earth-directed components.



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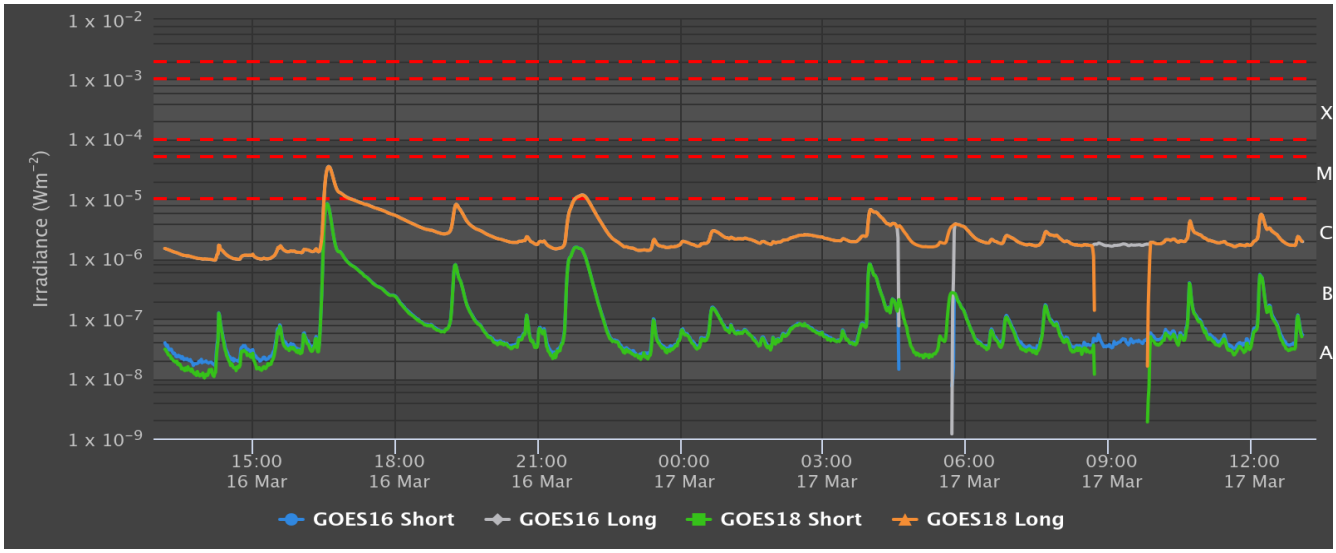
Radio Blackouts - X-Ray Flares:
Solar activity increased to moderate following M3.5 and M1.2 flares from a region currently yet to round the southeast limb, this in contrast to previous background X-ray activity near the B/C boundary in the wake of Ex-AR3599's departure over the western solar horizon to end the past UTC working week. Helioseismology and visible looping suggests that a larger region is projected to rotate onto the northeast disc later in the current UTC weekend - this may be Ex-AR3590, which was the source of several Strong flares on the previous rotation. The source of the recent moderate flare activity appears further from the southeast limb, with an arrival perhaps expected into day 2 (18 Mar) although this region evidently already increasing flare risk.
Low to moderate solar activity expected with ongoing C-class activity and a rising chance of further isolated M-class activity, this looking to be largely as a result of the approaching regions although full analysis of risk will remain impossible until these regions become visible.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	20	30	30	30
Very Active	R3 to R5 X Class	No	5	5	5	5

Figure 4: MOSWOC X-Ray Flux trace.



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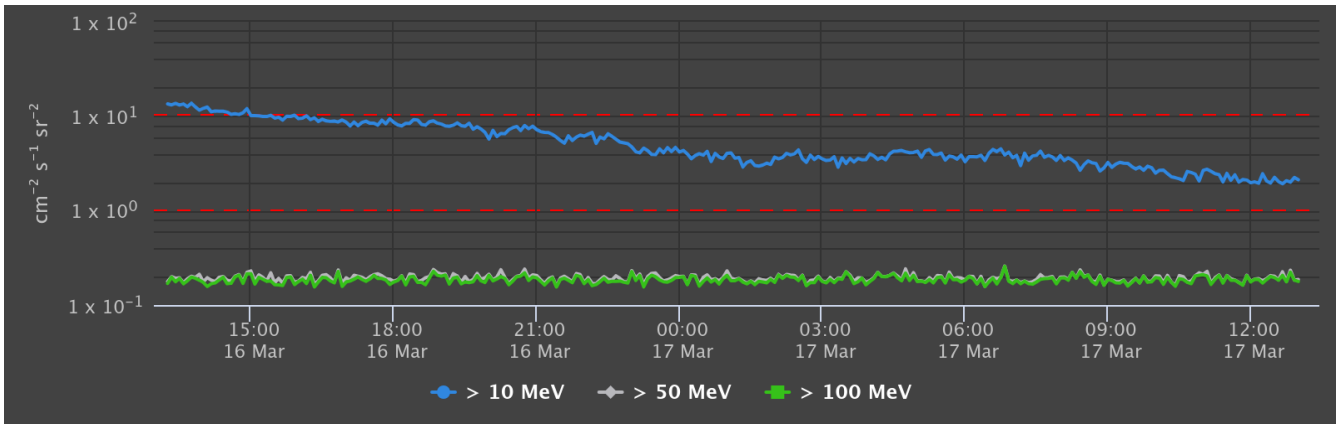
Solar Radiation Storms - (High Energy Protons):
Solar radiation levels have fallen below S1 as the response to the 15/0610UTC C5.9 flare continues to decline. Proton levels should continue to show a gradual decline over the coming hours. The main forecast focus is therefore the likelihood of any further enhancements, with this now considered increasingly unlikely given Ex-AR3599's position well onto the far side and the lack of any suitable successor on the current western disc.

A regression to a background risk for further S1 storms is therefore expected into the new UTC working week given the apparently magnetically simple sunspot regions facing Earth at present.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	Yes	10	1	1	1
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

Figure 5: GOES16 Proton Flux.



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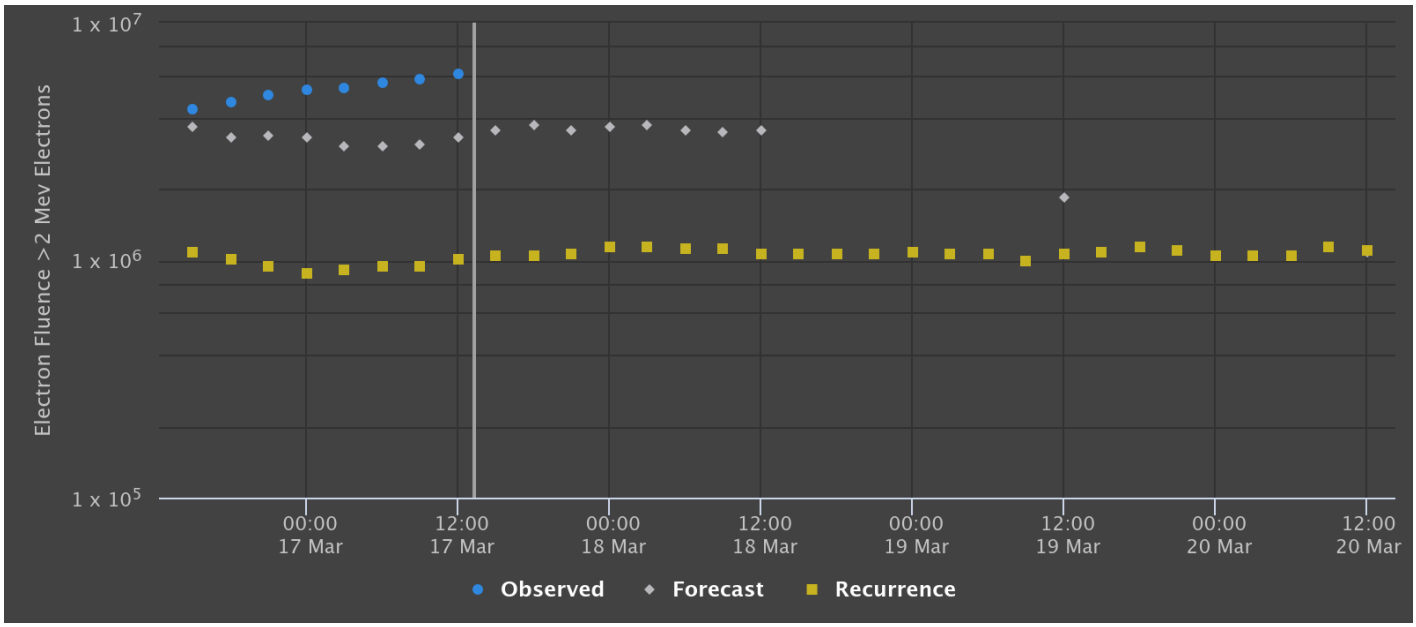
High Energy Electrons Event (≥ 2MeV):
No significant fast wind enhancements are expected during the period. MOSWOC REFM indicates as such, although this must be treated with some caution given the possible polluting influence of glancing CMEs in the period reducing confidence somewhat.

There is the potential for a more Earth-directed CME to arrive later in the period, after a recent large filament lift-off near south-centre disc at 17/0230UTC, which is currently under-going analysis. Awaiting results for any potential arrival, probably late in the period, days 3 or 4 (19-20 Mar), with a slight chance of seeing an increase in electron flux ahead of any potential CME arrival.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	1	1	5	5
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

Figure 6: MOSWOC REFM electron fluence, observation and recurrence.



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